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Luiz Antonio Del Ciampo

Department of Puericulture
and Pediatrics Ribeirão Preto
Medical School-University of
São Paulo, Brazil

Ieda Regina Lopes Del Ciampo

Department of Medicine-
Federal University of São
Carlos, São Paulo, Brazil

Effects of energy drinks on adolescent health

Luiz Antonio Del Ciampo and Ieda Regina Lopes Del Ciampo

Abstract

Energy drinks are non-alcoholic beverages with variable composition of stimulants, vitamins, and herbal extracts that can provide mental and physical stimulation and improving concentration. The consumption rate is growing among adolescents and evidence indicating that adverse health effects is growing and concerns have been raised both in the scientific community and among the general public about the health impact of these products. This paper presents the main characteristics of the composition of energy drinks and their effects on the organism when consumed alone or in association with alcoholic beverages, highlighting the risks to physical and emotional health of adolescents. Also, it discusses some aspects about measures of prevention about habits and consumption of energy drinks.

Keywords: Energy drinks, adolescent, caffeine, adolescent health

Introduction

Since its appearance in 1969 the consumption of energy drinks (ED) has been growing worldwide, especially among adolescents, with more than 500 brands available on the market and 6 billion cans sold in 140 countries. The aggressive marketing strategies, easy and extensive accessibility in convenience stores, supermarkets and grocery stores and relatively low price has made them both acceptable and readily available for adolescents and young adults [1-3]. Several studies around the world confirm that the prevalence of adolescents reporting ED consumption vary from 20% to 50% [4].

Energy drinks are non-alcoholic beverages that can provide mental and physical stimulation and improving concentration, energy and athletic performance [5]. Due to ED being consumed at low temperatures people may several over a short period. The composition of ED is variable in concentrations and forms, including one or several stimulants: caffeine associated to herbal extracts (guarana, ginseng, ginkgo biloba, yerba mate), taurine, inositol, glucoronolactone, L-carnitine and B-vitamins. ED category includes two types of products: drinks (sold in 8-32 oz containers) and shots (2-2, 5 oz single serving) with different concentrations of stimulant substances [6].

The consumption rates is growing among adolescents because they want to increase concentration, try to compensate for less periods of sleep and fatigue (staying awake), to ingest more energy while studying [7-9], and mix with alcoholic beverages for many purposes as: liking the taste, hiding the flavor of alcohol and avoiding a hangover, to drink more, to be happy, to get drunk, as a means of celebrating or social bonding, due to peer pressure and to reduce shyness [10, 11]. Evidence indicating adverse health effects of ED consumption is growing and concerns have been raised both in the scientific community and among the general public about the health impact of these products [12, 13].

One of the main groups of ED consumers consists of adolescents. Adolescence is defined as a biopsychosocial period comprising the second decade of life beginning with the body changes of puberty, passing through cognitive maturation and ending with social, professional and economic insertion in adult society. For this process to be carried out, it is necessary for the organism to receive nutrients in quantity and quality, with the purpose of supplying all the needs [14]. The recommended dietary energy requirements in adolescents are defined to maintain health, promote optimal growth and maturation, and support a desirable level of physical activity [15]. Nutritional needs during adolescence are considerable because of the increased growth rate and changes in body composition associated with puberty. The dramatic increase in energy and nutrient requirements coincides with other factors that may affect adolescents' food choices and nutrient intake and thus, nutritional status. These factors, including the quest for independence and acceptance by peers, increased mobility, more time spent at school and/or work activities, and preoccupation with self-image, contribute to the

Correspondence

Luiz Antonio Del Ciampo

Department of Puericulture
and Pediatrics Ribeirão Preto
Medical School-University of
São Paulo, Brazil

erratic and unhealthy eating behaviors that are common during adolescence [16]. On the other hand, adolescents have been experiencing increasing amounts of stress and expectations both at school and at a play, and consequently, they have been looking for an easy source of more energy that would enable them to study harder or win at sports [17]. During the second decade of life the human being needs 9 hours of sleep daily. Factors that interfere with sleep can certainly cause difficulties for the adolescent, such as caffeine that stimulates the adrenergic system and could induce alertness and waking that result in short sleeps time by reduction of the slow-wave or deep sleep and altered sleep architecture or rapid eye movement/non rapid eye movement sleep [14].

Factors that interfere with nutrition during adolescence may have repercussions for a lifetime. In the second decade of life bone size and bone mass increase rapidly being that the accumulation of total bone mineral between the ages of 8 and 18 years is approximately 146 grams per year, with the greatest deposition occurring during puberty. Adequate calcium intake is necessary to maximize peak bone mass and to minimize the risk of fractures in adolescence and the development of osteoporosis in adulthood [18]. Approximately one-half of total body calcium is laid down during puberty in females and one-half to two-thirds in males; by the end of puberty, males have nearly 30 percent more total body calcium than do females [19]. In this regard it should be remembered that caffeine interferes with intestinal calcium absorption.

Adolescents that who regularly consume ED can become dependent on them and even moderate consumption may be detrimental [20] due to its high content in sugars and sodium ED contributes to inappropriate diet-related behaviours like obesity epidemic [4]. The amount of sugar contained in 500 mL of an ED is about 54 g, more than 200 calories. Authors have found that those who report consuming ED are less likely to eat breakfast on a school day, are negatively associated with fruits, vegetables and milk, and more likely to report regular consumption of fast and junk food [3].

Composition of Ed

The main components of ED and their effects on the organism are:

1. Caffeine: Is probably one of the psychoactive substances

mostly consumed in the world and is also presented in numerous foods, beverages and certain medicines. Is a natural alkaloid found in more than 60 plants including coffee beans, tea leaves, cola nuts, guarana berries and cocoa pods [21]. Caffeine is rapidly absorbed in the gastrointestinal tract (30 to 45 minutes), reaches the maximum blood concentration in 1:00h to 1:30h, is distributed to all tissues, and readily cross the blood-brain barrier to exert its effects, being a potent antagonist of central and peripheral nervous system adenosine receptors, and inhibits phosphodiesterase actions thereby simulating the releases of excitatory neurotransmitters [22].

At higher concentrations caffeine also promotes calcium release from intracellular stores and interferes with gamma-aminobutyric acid (GABA) receptors. These alterations result in potential susceptibility to cardiac arrhythmias due to chronotropic and inotropic effects [23].

The major pathway of metabolism in humans occurs in the liver, metabolized by microsoma cytochrome P450, giving rise to theophylline, paraxanthine and theobromine. Caffeine has multiple systemic effects on the cardiovascular, gastrointestinal, neuropsychiatric, and endocrine systems and the impact on health may varies by age, sex, drugs association, genetics and environmental factors [24]. Currently, hundreds of brands are marketed, with caffeine content ranging from 50 mg to over 500 mg per can or bottle. Safe level of consumption for adolescents is no more than 2,5mg/kg body weight [25]. Caffeine toxicity may occur above daily concentrations of 400 mg for adults, 100 mg for adolescents and 2,5mg/kg of body weight for children [4].

Adolescents are more likely to experience side effects of caffeine due they are not habitual caffeine users, have lower levels of tolerance, smaller body surface area for drug distribution and less effective metabolic excretion capabilities and the tendency to consume larger quantities of these beverages. Adolescents who have been consuming caffeinated products for less time than adults are candidates to experience adverse health effects because they have not built up as much of a tolerance to caffeine [9]. The physiological and behavioral effects of caffeine are dose-dependent and the over consumption of ED may cause inadequate nutritional habits and serious health issues as can be seen in table 1.

Table 1: Effects of caffeine consume excess

Cardiovascular	Palpitations, tachyarrhythmia, high blood pressure, increased heart rate, coronary artery spasm, myocardial ischemia and infarction, chest pain, decreasing endothelial function, coronary artery thrombosis, aortic dissection, atherosclerosis, peripheral arterial disease, increasing platelet aggregation, increasing peripheral vascular resistance
Gastrointestinal	Nausea, vomiting, increased gastric acid, gastric ulcers, bowel irritability, diarrhea, gastrointestinal reflux
Neurologic	Tremors, seizures, insomnia, headache, irritability, vertigo, increased intracranial pressure, cerebral edema, stroke, rigidity, paralysis, sleep disturbance
Psychiatric	Hallucination, aggressiveness, phobias, agitation, dizziness, anxiety, panic attacks, violent behaviors, nervousness
Other	Rhabdomyolysis, hypokalemia, hypocalcemia, diuresis, muscle spasms, dehydration, metabolic acidosis, decreased bone mineralization

Little information is available on potential interactions between the active ingredients of ED and other substances presented at medicine, food, and drugs. Caffeine can interact with many substances such as monoamine oxidase inhibitors, pseudoephedrine, lithium, adenosine, oral contraceptive hormones, dipyridamole, peppermint, betablockers, antipsychotic drugs (clozapine, olanzapine),

benzodiazepines, quinolones, and increase its effect and toxicity.

Caffeine concentrations may increase with the inhibition of its metabolism. This occurs in the end of pregnancy, in female patients with liver disease and obesity, in some food and alcohol intake and with the use of some medications such as antimycotic drugs (fluconazole, ketoconazole),

antiarrhythmic drugs (diltiazem, verapamil), antidepressants (paroxetine, fluoxetine, fluvoxamine), antipsychotic drugs (clozapine, olanzapine), methylxanthines (theophylline), oral contraceptive, cimetidine, quinolones and allopurinol.

Individuals' pre-existing conditions that can potentiate caffeine mechanisms of action and interactions with other substances that have a synergistic effect when consumed with caffeine or are capable of increasing caffeine's blood levels [26]. When the prolonged use of caffeine is interrupted abruptly may occur the so-called withdrawal syndrome, whose symptoms begin between 12 and 24 hours, reaching its maximum between 24 and 48 hours, remaining for about a week. The main symptoms of this syndrome are fatigue, headache, tiredness, apathy, lethargy, insomnia, dizziness, irritability, difficulty concentrating, depressed mood, nervousness and muscle tension.

The Diagnostic and Statistical Manual of Mental Disorders (DSM5) [27] classifies as "caffeine intoxication" a clinical condition characterized by insomnia, anxiety, tremors, restlessness, tachycardia, psychomotor agitation, and GI disturbances, that requires treatment in appropriate conditions.

2. Taurine: 2-aminoethylsulphonic acid is a non-protein amino acid present in almost all animal tissue and the most abundant free intracellular amino acid in human cells [28]. Taurine is involved in numerous biological and physiological functions like osmoregulation, antioxidant and anti-inflammatory actions, a central nervous system neuromodulator, stabilizing membrane potential in skeletal muscles and mitochondrial function [28]. Taurine has an inotropic effect on cardiac muscle similar to that caffeine and potentiates caffeine-induced muscle contracture [29, 30]. A normal diet provides between 120 and 180 mg of taurine daily and the consumption of one 8-oz ED can increase the average intake 6 to 16 times. Taurine has widespread distribution and there may be a link between taurine excess and various cytochrome P450 systems responsible for hepatic drug metabolism, with inhibition of the enzymes responsible for the breakdown of more than 70 substrates, including antidepressants, antiepileptics, anesthetics, analgesics and antibacterial [31-33]. 95% of taurine is excreted in urine and when combined with caffeine taurine potentiates its effects on the sarcoplasmic reticulum on cardiac myocytes [11].

3. Guarana: is a plant extract whose seeds contain significantly more caffeine than coffee beans. It is marketed to increase energy and enhance physical performance [1]. Guarana seeds contain three times much caffeine compared to coffee beans [34] and the release of guaranine is slower than caffeine, prolonging its effects on the body. Usually is consumed for the purpose to improve alertness, reaction time, speed of information processing, memory, mood and performance in physical exercises. Each gram of guarana can contain 40 to 80 mg of caffeine, and it has a potentially longer half-life because of interactions with other plant compounds [1]. Is more slowly absorbed into the GI tract and have a longer lasting effect than caffeine sourced from coffee beans.

4. Carnitine: is a hydrophilic quaternary amine which is an essential metabolite to transport of long-chain fatty acids from the cytosol to the mitochondrial matrix, where β -

oxidation takes place. The highest concentration is present in heart and skeletal muscle [35].

Ed and Alcohol

The ingestion of ED with alcohol has become dangerously popular among adolescents and is an increasing public health concern because this association is a new risk factor for heavier and harmful alcohol consumption [36]. Alcohol-mixed energy drinks (AmED) use is defined as the co-consumption of alcohol with energy drinks packaged pre-mixed, hand-mixed in one beverage, or ingested separately in a drinking session [37]. This practice includes drinking cocktails of alcohol combined with energy drinks, or pre-mixed caffeinated alcoholic beverages, and drinking alcohol and energy drinks separately but within the same drinking occasion [38].

Adolescents who consume Am ED were more likely to experience adverse consequences due to their own drinking compared who only drank alcohol [39]. Drinkers may not feel the symptoms of alcohol intoxication because the feeling of "wide awake drunkenness" keeping the individual awake longer with the opportunity to continue drinking and encourage greater consumption [13, 40, 41].

If excessive alcohol intake alone is particularly problematic for the adolescent brain, which is still undergoing structural development [42], the consumption of ED and Am ED among adolescents is associated with negative outcomes like lead to poor decision making and increased levels of risk behaviors as a being taken advantage of someone sexually, drink driving, smoking, failure to use seatbelts, illicit drugs use, fighting, violence, and being injured [9]. The frequency of ED use was a significant predictor of the illicit use of prescription stimulants, being directly related to the quantities and the number of days of ED consumption [41]. Adolescents who consume EDs combined with alcohol are more likely to use marijuana, to consume alcohol and to be heavy episodic drinkers, meet criteria for alcohol dependence, and decreased perceived intoxication because blood alcohol concentrations do not differ when alcohol is administered with and without the ED enhanced stimulation [43, 33].

Am EDs reduced the subjective perception of alcohol intoxication but not significantly reduced alcohol-related objective motor coordination and visual reaction time [43]. Because adolescents are drinking ED to keep them focuses, they may feel a need to take in more of these beverages to feel good [45].

Alcohol consumption can increase the half-life of caffeine by up to 72%, and may potentiate the ED exposure effects. A variety of pre-mixed caffeinated alcoholic beverages were available with brand names and the consumption is becoming more widespread around the world. In recent years, emergency department visits in the US involving Am ED doubled among adolescents and young adults [46]. Caffeine use, with or after alcohol consumption, has been erroneously perceived as a remedy to reverse the negative effects of alcohol intoxication [47]. Caffeine is a diuretic, and ED plus alcohol are dehydrating. The combination of fluid loss from sweating during exercise with the diuretic effect of caffeine causes increased risk of dehydration [48]. This association could increase body water loss through urine, reduce plasma volume, and negatively affect thermoregulation and cardiovascular function [46]. Although there have been many studies on Am ED consumers, the

problem is growing without actions being taken to limit the use of these beverages among adolescents [49, 50].

Conclusions

Energy drinks have become part of the daily routine of adolescents, and it is necessary increase awareness and educating adolescents about the potential harmful effects of this beverage. Besides having no therapeutic effect, the largely unknown effect, dosage and interactions of the various ingredients, combined with reports of toxicity, suggest that ED may put some adolescents at risk for serious adverse health effects [11, 41, 43, 44].

There is a fine line that differentiates positive effects from minimal amounts of energy drinks consumption and harmful effects that occur with excessive use [14, 45]. The American Academy of Pediatrics Committee on Nutrition and the Council on Sports Medicine and Fitness have concluded that “caffeine and other stimulant substances contained in ED have no place in the diet of children and adolescents”. The American Academy of Pediatrics and The American Medical Association has state that ED should never be consumed by youths <18 years because of potential adverse consequences on children’s developing neurological and cardiovascular systems [46, 47].

Adolescents have received less attention than other age groups regarding the risks associated with ED although they were likely to be unaware of the side-effects on their health. Therefore, it was recommended that any labelling and marketing of ED should include appropriate health warnings [2]. Advertisements were the main single source of information and it is very important to instruct adolescents to read the labels on any product in order that knows clearly the composition, side effects and adverse interaction of any substances [9, 28]. Health educational programmes in mass media and in schools should be established so as to educate the public on the health aspects of ED. Identifying consumers with the greatest likelihood of reporting motivations associated with greater harms, and establishing the correlates of their consumer subtype membership, is also crucial to informing strategic harm minimization efforts targeted at high-risk groups [48-50].

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